FLAT-ROUND JOINT IN A "CT" OR "SERPENTINE" FIN CORE

FIELD OF THE INVENTION

The present invention generally relates to heat transfer products using a CT or Serpentine fin style core, including but not limited to, radiators, shell and tube type heat exchangers, charge air coolers, oil coolers, and fuel coolers. More particularly, the invention relates to a Flat-Round joint used in a CT or Serpentine fin core.

BACKGROUND OF THE INVENTION

Currently the tube-to-header assembly of CT and Serpentine style radiators utilizing oblong tubes use a header with oblong openings that are typically the same shape as the tube, only slightly larger. The tube is bonded, non-mechanically, to this header using a solder dip process, a weld process, or a brazing process. Such tube ends with an oblong cross-sectional shape will have a diameter in one direction greater than the diameter in another (usually perpendicular) direction, which is referred to herein as the "major diameter" and "minor diameter", respectively.

Creation of a tube-to-header assembly or joint is accomplished by affixing a plurality of tubes having oblong ends into a plurality of corresponding oblong openings of approximately equal cross section in the header. As shown in the prior art (e.g., U.S. Patent 5,150,520 to DiRisi), the tubes

are inserted into corresponding openings in the header wall whereupon the minor diameter of the tube end is reduced and the major diameter of the tube end is increased to create a contacting fit around the circumference of the header. Each tube is non-mechanically bonded to a corresponding collar opening in the header wall to form a plurality of tube-to-header joints. The collar openings are formed in the same operation when the plurality of openings are punched into the header.

Unfortunately, these prior art bonding processes add thermal stress to the tubes at their respective bonding locations, thereby increasing the grain size of the tube and reducing the tensile strength of the material at this point. A reduction in such tensile strength can result in pressure cycle fatigue and failure. This fatigue is also a result of the stresses applied during thermal cycling. Thermal cycling occurs during a cyclic change in coolant temperature, when idol coolant, initially at ambient temperature, becomes significantly hotter during use. During the thermal cycle, deformation of the header may occur as a result of the weight of the heat exchanger and the coolants therein, thereby weakening the core-to-header assembly, which leads to failure of the bond. Furthermore, the addition of the secondary filler material, used to aid in strengthening the stressed tubes, can be a source for

environmental concerns, such as the use of leaded solder for the secondary filler material.

SUMMARY OF THE INVENTION

In one aspect, the invention generally features a bond between a tube and a header in a heat transfer device. At least one end of the tube is generally circular so as to fit into a corresponding circular opening in the header. The circular end of the tube is then inserted into the circular opening in the header and then a bond is formed between the tube and the header.

Another aspect of this invention is to provide a Flat-Round joint in either a CT or Serpentine fin core by creating a bond between a coolant tube having an oblong cross-section and a header of a heat exchange device. One end of the coolant tube is shaped into a circular cross section. The circular end of the tube is inserted into a circular opening on the header and a bond is formed between the circular tube end and the header.

Yet another aspect of this invention is to provide an improved Flat-Round joint in combination with a coolant tube having an oblong cross-section and a header in a heat transfer device having either a CT or a Serpentine fin core.

OBJECTS OF THE INVENTION

It is, therefore, one of the primary objects of the present invention to provide a joint in a CT or Serpentine fin core of a

heat exchange device which will substantially overcome the shortcomings of prior art tube-to-header assemblies as described above.

Another object, of the present invention, is to provide a Flat-Round joint in either a CT or Serpentine fin core which enables forming a bond between a coolant tube having an oblong cross section and a header.

Yet another object, of the present invention, is to provide a Flat-Round joint in either a CT or Serpentine fin core that reduces the row pitch in both the staggered and parallel style arrays.

A further object, of the present invention, is to provide a mechanical bond between a coolant tube having an oblong cross section and a header in a CT or serpentine fin core exchanger.

In addition to the above-described objects and advantages of the present invention, various other objects and advantages will become more readily apparent to those persons who are skilled in the same and related arts from the following more detailed description on the invention, particularly, when such description is taken in conjunction with the attached drawing, figures, and appended claims.

DESCRIPTION OF THE DRAWING

Fig. 1 is a partial oblique view of the top of the header of a tube-to-header assembly used in prior art.

Fig. 2 is a partial oblique view of the side of the header, tubes and fins of a tube-to-header assembly used in prior art.

Fig. 3 is a partial oblique view of the top of the header of a presently preferred embodiment of the tube-to-header assembly.

Fig. 4 is a partial oblique view of the side of the header, tubes and fins of a presently preferred embodiment of the tube-to-header assembly.

FIG. 5 is an oblique view of an inside sizing tool and an outside sizing tool.

FIG. 6 shows a parallel circular opening arrangement in a header.

FIG. 7 shows a staggered circular opening arrangement in a header.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Prior to proceeding to a much more detailed description of the present invention, it should be noted that identical components which have identical functions have been identified with identical reference numerals throughout the several views illustrated in the drawing figures for the sake of clarity and understanding of the invention.

Turning now to the drawings, FIGs. 1 and 2 are oblique views of a prior art type of tube-to-header assembly, generally designated 10. The tube-to-header assembly 10 includes a

header 12, a plurality of core fins 14, and a plurality of oblong tubes 16 that are secured to the header 12 by means of a non-mechanical bond 18. The tubes 16 have a major dimension that is several times greater than the minor dimension. This non-mechanical bond 18 is accomplished through various processes, such as welding, brazing, or solder dipping of the oblong tubes 16 into corresponding oblong openings (not shown) in header 12. The oblong openings in the header 12, which receive the tubes 16, are formed by a punching operation. The use of a punch for forming these openings puts an upper limit of the thickness of the header 22.

Fig. 3 is an oblique view of the presently preferred embodiment of the present invention. Reference number 20 generally indicates the preferred tube-to-header assembly utilizing Flat-Round joints. The tube-to-header assembly 20 includes a header 22 having a plurality of circular openings 28 formed therein that are slightly larger than one end of coolant tubes 16. The one circular end 26 of the oblong coolant tubes 16 has been shaped into a circular cross section that is bonded into the headers circular openings 28. The process for shaping these Flat-Round joints is described below. Additionally, it should be understood by those persons skilled in the art that a generally round tube could be used in place of such oblong coolant tubes 26. Further, such tube-to-header

assembly 20 can be produced by forming a bond between a coolant tube 16 having a generally oblong cross-section and a header member 22 of a heat exchange device. The header 22 has a predetermined plurality of generally circular openings 28 which have a predetermined diameter. Openings 28 are formed therein in one of a CT and a serpentine fin configuration.

Fig. 4 provides another view of the tube-to-header assembly 20. When the ends of the tubes 16 are shaped into a circular cross section, the outsides of the tubes 16 are rounded as described below. The portions 24 of the tubes 16 next to the header 22 are also rounded as shown in FIG. 4.

FIG. 5 is an oblique view of an internal sizing tool 30 and an external sizing tool 32. The use of these tools is described below.

FIG. 6 shows a parallel arrangement of the circular openings 28, and FIG. 7 shows a staggered arrangement of the circular openings 28. In the prior art of the tube-to-header assembly 10, shown in FIG. 1, the major diameter of the oblong tubes 16 limits the row pitch of the openings in the header 12. This minimum row pitch includes not only the major diameter of the tubes 16, but also the width of the non-mechanical bonds 18. In the present invention there is essentially no minimum separation between adjacent circular openings 28, and therefore the row pitch can be less than that for the prior art tube-to-

header assembly 10. As shown in FIG. 7 the circular openings 28 can be staggered as an alternative to the parallel arrangement shown in FIGs. 3 and 6.

Turning now to the process for forming the Flat-Round joint of the present invention, one circular end 26 for each of the tubes 16 is shaped into a circular cross section by an internal sizing tool 30 shown in FIG. 5. The lip of circular end 26 of the tubes 16 is also rounded using an external sizing tool 32.

The circular openings 28 are formed in the header 22, and the circular ends 26 of the tubes 16 are inserted into the circular openings 28 and extend slightly out the other side of the header 12. The circular openings 28 may also be threaded to further strengthen the Flat-Round joint. The mechanical bond is then formed using a rolling tool (not shown) to roll the circular end 26 of the tube 16 into the circular openings 28 in the header 22. In the rolling process the tubes circular end 26 and the pressure of the rolling tool expands the circular openings 28. When the rolling tool is removed, the steel header 22 contracts back more than the brass tubes circular end 26 and thus aids in forming a strong Flat-Round joint. Then the circular end 26 of the tubes 16 extending above the surface of the header 22 are removed to make them flush with the surface.

There are several advantages the Flat-Round joint of the present invention. While the prior art header 12 is restricted to a maximum thickness, the header 22 of the preferred embodiment is thick enough to support the mechanical bond between the tubes circular end 26 and the header 22. This thicker header reduces the deformation of the header when the tube-to-header assembly is in use. Moreover, the strength of thicker header allows longer tubes than in the prior art tube-to-header assemblies thereby increasing the heat exchange capability of, for example, a heat exchanger.

The Flat-Round joint shown in the preferred embodiment forms a stronger bond than the prior art bond, and therefore makes it less sensitive to operational pressure cycle heat, and therefore has fewer failures than the prior art bonds. Also, the mechanical bonding process described above for the preferred embodiment may utilize an adhesive, but it does not subject the tubes to heat as in the prior art bonding process, and therefore does not increase the grain size of the tube or reduce the tensile strength of the material in the tubes in the header when the bond is made. Finally, the mechanical bond does not raise environmental concerns when the tube-to-header bond is made since a secondary filler material is not used.

While the present invention has been described by way of a detailed description of a particularly preferred embodiment, it

will be readily apparent to those of ordinary skill in the art that various substitutions of equivalents may be affected without departing from the spirit or scope of the inventions set forth in the appended claims.